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Impact of Land use Practices on Soil fertility status of Dryland Alfisols

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ABSTRACT : In order to assess the impact of long term land -use systems on soil fertility, a study was undertaken at Gunegal Research Farm of Central Research Institute for Dry land Agriculture, Hyderabad situated at 17^0, 40', 40.4' N latitude and 78^0, 39', 55.7'' E longitude and at a mean sea level of 626 m. Study revealed that there was considerable variation in the status of organic carbon, available phosphorus and potassium in soil under different land use systems. The organic carbon content in the soil across the land use systems ranged from as low as 0.103 % to as high as 1.27%. About 47 and 40% of the blocks under mono-cropping and intercropping system respectively were rated as low with respect to organic carbon (less than 0.5%) which is a measure of available nitrogen also .The blocks with medicinal plantations and forestry were rated as high (more than 0.75%) in organic carbon status. Most of the blocks under horticulture and agro-forestry were also rated as medium to high in organic carbon. The minimum available phosphorus recorded in the farm was 6.63 kg P ha $^{-1}$ and the maximum content recorded was 36.43 kg P ha $^{-1}$. A minimum of 86 kg K ha^{-1} and a maximum of 740 kg K ha^{-1} were recorded from the different blocks of the farm. Of the three soil fertility parameters, the available potassium content exhibited highest coefficient of variation (77%), followed by organic carbon (38.33 %) and available phosphorus (36.4 %). The content of DTPA-extractable Fe, Cu and Mn were recorded above the critical limits (4.5, 0.2, 2.0 ppm for Fe, Cu and Mn, respectively) in all the blocks indicating that the land use practices do not have any effect on the status of these nutrient cations . However, DTPA-extractable Zn was found above the critical limit (0.6 ppm) only in the blocks where forestry and medicinal systems were practiced and was below the critical limit in blocks continuously covered under mono-cropping.

Key words: land use systems, soil fertility, Alfisol, macro and micro nutrients

Soil fertility is one of the important components of soil productivity. It is defined as the inherent capacity of soil to supply the essential nutrients to the plants. Native soil fertility is a function of various soil forming factors such as parent material and rocks from which the soil have been derived, type of vegetation, putting its signature on soil formation, climate, especially temperature and rainfall, diversity of soil organisms, slope etc. When soils are put to agriculture with diversity of lands uses, the removal of nutrient from the soil varies extremely depending upon the level of productivity of each kind of system. Use of fertilizers to replenish the exhausted nutrients and to achieve specific yield targets also significantly influence the soil fertility. Recycling of remnants of crop residues advertently or inadvertently left in the soil, contribution of nutrients through leaf litter fall of perennials, root excretions and stem wash also influence fertility status of soil. Mining and recycling of nutrients through pastures and tall grasses also play an important role in soil fertility build up. Therefore, the development of spatial data base on soil fertility as influenced by different land use systems and management practices over a long term period in a catchment, watershed or field scale is of paramount importance for planning appropriate nutrient management strategies. Keeping in view the above, the present study was undertaken to assess the fertility status of soil under different land uses being practiced over a period of time in a farm scale and to prepare soil fertility map for planning suitable nutrient management strategies.

Materials and Methods

Gunegal Research Farm (GRF) of Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad, wherein different land use practices have been in practice for the past 20-25 years was selected for the study. GRF is located at a latitude of 17^0, 40', 40.4'' N , longitude of 78^0, 39', 55.7'' E and at a mean sea level of 626 m. The total area of this farm is 80 hectares. The research farm has about 67 blocks in which different land-use systems are being practiced. In all, about 6-land use systems viz., mono cropping (sorghum, castor, groundnut), agro-forestry, horticulture (mango, sweet lime), forestry, intercropping (sorghum+pigeonpea), and medicinal plantations are being practiced in the farm. The area under each land use being practiced in the farm is depicted in Figure 1.

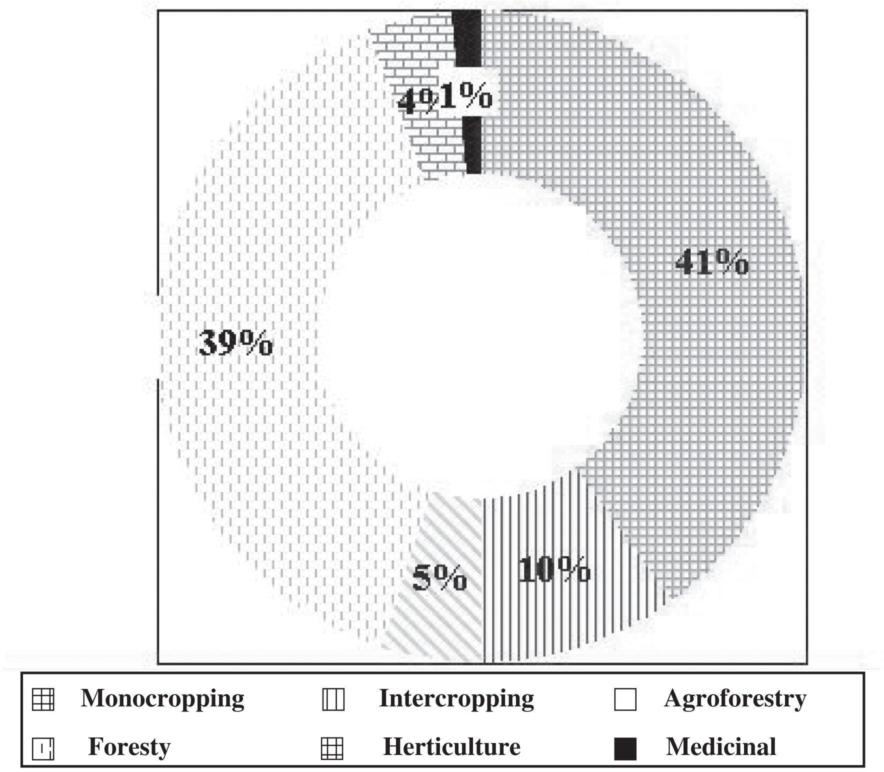

Fig 1. Percent area under different land use systems at GRF during 2005

Composite surface soil samples (0-20 cm) from each block (geo-referenced) were collected during the month of November 2005. After processing, the samples were analyzed for various soil fertility parameters. The methods followed for assessing the fertility status of the soils are as follows: organic carbon (Walkely and Black 1934), available phosphorus (Olsen *et al,* 1954), available potassium, DTPA-extractable Fe, Cu, Mn and Zn (Lindsay and Norvell, 1978)

For assessing the present fertility status of blocks in GRF under different land use systems , the results of the soil analysis with respect organic carbon, available phosphorus and potassium under a particular land use was classified either as low, medium or high category based on the fertility ratings. The fertility ratings employed for classifying the soil either as low, medium or high are as follows: organic carbon <0.5 % low, 0.5 – 0.75% medium and >0.75% high, available phosphorus <11 kg P ha^{-1} low, 11-25 kg P ha^{-1} medium and >25 kg P ha^{-1} high, available potassium (<110 kg K ha^{-1} low, 110-280 kg K ha^{-1} medium and >280 kg K ha^{-1} high). The data on percentages of blocks falling in low, medium or high category in a particular land-use are presented in Table 1. Similarly, the contents of DTPA- extractable micronutrients such as Fe, Zn, Cu and Mn were classified into deficient and sufficient categories based on the critical level for each nutrient reported in the literature.

Results and Discussion

Spatial variability of macronutrients

The results of the soil analysis with respect to organic carbon, available phosphorus and available potassium are presented in the Table 2. The data on the descriptive statistics presented in Table 2 reveal that there is a considerable variation in the status of organic carbon, available phosphorus and potassium in the farm soil as evident from the minimum, maximum, mean and coefficient of variation values. The organic carbon content of the farm ranged from as low as 0.103 % to as

Table 1. Percentages of soil samples testing low, medium and high for organic carbon, available phosphorus and potassium under different land uses in GRF.

Land use	Organic carbon			Available phosphorus			Available potassium		
	Low	Medium	High	Low	Medium	High	Low	Medium	High
Mono cropping (37)	47	24	29	11	81	8	34	63	3
Agro-forestry (7)	14	57	29	29	71	-	29	71	-
Horticulture (5)	-	75	25	20	60	20	20	80	-
Medicinal (3) plantations	-	-	100	3	33	33	-	25	75
Forestry (4)	-	-	100	-	25	75	-	-	100
Intercropping (11)	40	20	40	10	60	30	40	60	-

Values in the parentheses indicate the number of blocks under each land use

high as 1.27%. The minimum available phosphorus recorded in the farm was 6.63 kg P ha^{-1} and the maximum content recorded was 36.43 kg P ha^{-1}. A minimum of 86 kg K ha^{-1} and a maximum of 740 kg K ha^{-1} of available potassium were recorded from the different blocks of the farm. Of the three soil fertility parameters, the available potassium content exhibited highest coefficient of variation (77 %), followed by organic carbon (38.33 %) and available phosphorus (36.4%).

Data presented in Table 1 reveal that about 47 and 40% of the blocks under mono-cropping and inter-copping system were rated as low with respect to organic carbon (less than 0.5%) which is also an indicator of available nitrogen, whereas the status of N in all the blocks under medicinal plantations and forestry was rated as high (more than 0.75%) in organic carbon . All the blocks and about 86% of those under horticulture and agro-forestry, respectively were rated as medium to high with respect to organic carbon. The high content of organic carbon recorded in blocks practicing forestry, agro-forestry and horticultural blocks might be due enrichment of the soil due to continuous addition and recycling of the leaf litter. Dashrath Singh *et al.* (1983) and Jha *et al.* (2000) have also reported higher organic carbon and nitrogen content in soils under forestry, agro-forestry land uses as compared to those under agriculture at all the soil depths and they attributed the increase to enrichment of soil with leaf litter of trees. Mismatch between addition through external sources to the crop and continuous uptake of nitrogen by the sorghum, castor, maize, sunflower, etc raised on the mono-cropping blocks might have resulted in depletion of available nitrogen. Ramakrishna *et al.* (2004) have reported a net negative balance of nitrogen to the tune of –58 and –56 kg N ha^{-1} $year^{-1}$ under groundnut /pigeon pea and mung bean/ pigeon pea, respectively based on the on-farm trials conducted in dry zone of Myanmar.

With respect to available phosphorus, majority

Table 2. Descriptive statistics of the content of organic carbon, available phosphorus and available potassium in surface soil (0-20cm) at Gunegal research farm

Statistical parameter	Organic carbon (%)	Available phosphorus (kg ha^{-1})	Available potassium (kg ha^{-1})
Minimum	0.103	6.63	86
Maximum	1.27	31.06	740
Mean	0.623	17.37	190
Standard deviation	0.238	6.33	147
Coefficient of variation (%)	38.33	36.43	77.5

percentage of the soil samples under different land uses fell into medium category (11-25 kg P/ha)(Table 1). The data also revealed that about 89 and 90% of soil samples under mono cropping and intercropping were medium to high indicating build-up of phosphorus under these systems due to application of phosphatic fertilizers. Tarfadar *et al.* (1989) have reported higher content of available phosphorus in surface layers under crops, grass and tree-based land uses in arid regions of India. Balpande *et al.* (1994) have also reported significant build-up of available phosphorus under sorghum-pigeon pea intercropping system in Typic Chromusterts.

None of the blocks under intercropping system were high in available potassium (more than 280 kg K ha^{-1}) whereas, only 3% of the blocks under mono-cropping system represented high available K. About 34 and 40% of the blocks under mono -cropping and intercropping were low in available potassium (less than 110 kg K ha^{-1}) respectively indicating that continuous uptake in absence of regular additions might have resulted in depletion of available potassium. A net negative balance of -3.8 kg K $ha^{-1}y^{-1}$ under sole sorghum system in dry zones of Myanmar has been reported by Ramakrishna *et al.* (2004).

Micronutrients

With respect to micronutrients, the contents of DTPA-extractable Fe, Cu and Mn were above the critical limits (4.5, 0.2, 2.0 ppm for Fe, Cu and Mn, respectively) in all the blocks indicating that the land use practices do not have any effect on the status of these nutrients. With respect to DTPA-extractable Zn, it was observed that where forestry and medicinal systems were practiced, the available Zn content was above the critical limit (less than 0.6 ppm). However, in about 33% of the blocks practicing mono-cropping, the Zn content was below the critical limit (less than 0.6 ppm). Higher percentage of blocks recording low content of available Zn under mono-cropping as compared to forestry, agro-forestry, horticulture and medicinal systems might be due to continuous uptake of zinc by the crops like sorghum, castor, maize, sunflower, etc in absence of regular additions.

Based on the preliminary results it can be inferred that the mono-cropping systems that are being practiced in vast areas of drylands needs to be supplemented with potassium and zinc for achieving higher productivity and also for maintaining good soil health.

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